Keen (W. W.)

A LECTURE

ON

THE CLINICAL ANATOMY OF THE LOWER EXTREMITY AND ESPECIALLY OF THE KNEE AND ANKLE JOINTS

DELIVERED BEFORE THE

ANATOMICAL AND SURGICAL SOCIETY OF BROOKLYN

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ON THE CLINICAL ANATOMY OF THE LOWER EXTREMITY AND ESPECIALLY OF THE KNEE AND ANKLE JOINTS.[1]

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I HAVE selected the subject just announced not only because of its importance, but also because of its neglect. We study anatomy, it is true, on the skeleton and on the subject faithfully and frequently; but how seldom on the living model! Yet it is just here that we need our anatomy, when, in the person of the sick man, the bones are clothed with muscles, nerves and vessels, and all are covered and hidden with skin and fat. Hence I have ventured to call it "clinical anatomy," because it is the anatomy of the bedside.

In place of the sick man, I shall use to-night this finely-developed specimen of health—a man who has served me as a model for several years at the Pennsylvania Academy of the Fine Arts—and I trust that we shall be able to observe together some points that may be both interesting and instructive.

[1] A lecture delivered before the Anatomical and Surgical Society, May 10th, 1880.

Haydon says that he scarcely knows a knee properly and simply defined excepting in the Elgin marbles. Even artists, who pay the greatest attention to external form, have neglected it or misinterpreted it. And first, the obliquity of the joint-surfaces as contrasted with the elbow is a matter of importance. The humerus, when we are in the anatomical position, is nearly vertical, but the forearms diverge in consequence of the general plane of the joint running obliquely from without inwards and downwards. When therefore the forearms are flexed, the arms being kept immobile, the hands fall, not on the shoulders, as they would were the elbow exactly transverse, but near to or even across each other at the middle line. Now, were the knee so arranged, when we stoop, the heels would meet and our base of support be of the narrowest; but the general plane of the knee-joint being from without inwards and upwards, on stooping the tibiæ are flexed not toward the middle line nor straight backward, but a little outward, and so widen our base of support.

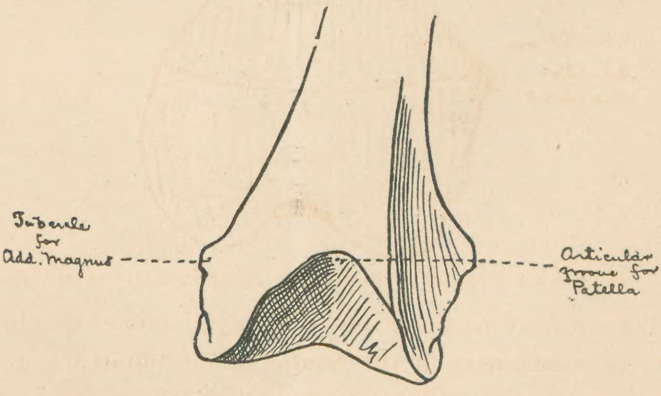

FIG. I.—LOWER END OF FEMUR. ANTERIOR SURFACE.

The first bony outline to which I call your attention, both on this skeleton and on the model, is this fossa on the external condyle for the origin of the popliteus. It is best

felt, as you can readily convince yourselves, in flexion. Now, such a point as this, like many others of which I shall speak this evening, has but little value of itself, and little, if any direct relation to any individual case of injury or disease; but our knowledge or ignorance of them is a fair index of our familiarity with the coast along which we are sailing. A novice may know the chief points, but only the old sailor knows every little headland, every jutting promontory, and every hidden rock, and to him, be it foggy or be it clear, blow it high or blow it low, what danger to avoid and what harbor to seek comes instantly and almost automatically. So to the surgeon, diagnosis becomes easy and error infrequent in proportion as he has it all at his finger ends.

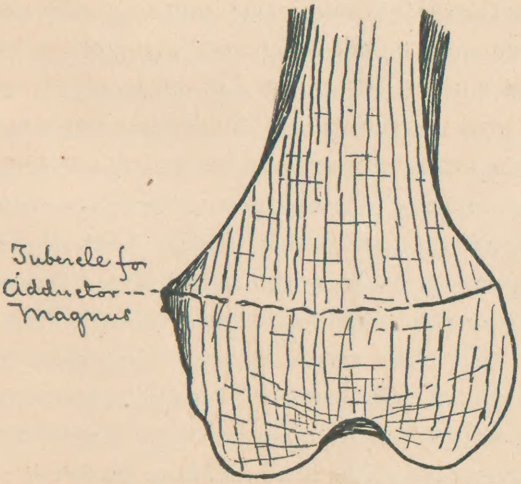

FIG. 2.—SAWN FEMUR SHOWING LINE OF EPIPHYSAL CARTILAGE.

Passing next to the external condyle, note this tubercle for the attachment of the tendon of the adductor magnus. The importance of this can scarcely be exaggerated. Its hypertrophy as an obstacle to cavalry service is rare and of little moment, and its value as a point of measurement is only occasional. Yet these, I think, are the commonest remarks made in regard to it. But look not only at this solid bone

but on this sawn one, and you will see that the tubercle marks two other points of importance; first, it is on a level with the upper margin of the trochlear surface for the patella; and, secondly, and most important, it marks the line of the epiphysal cartilage.

Both in the diagnosis of fractures and other injuries, and especially in resections and other operations at or near the knee, these two points are all-important. Resections of the knee are much rarer here than in England, but I think that not even there is the importance of this point appreciated as it deserves. The long bones grow in length at the epiphysal cartilages, but by no means with equal rapidity at the two ends; and in the femur it is precisely this lower cartilage that does the bulk of the work. Any interference with it, therefore, before growth is completed (and it is chiefly in childhood and adolescence that resections of the knee are done) must dwarf the corresponding leg and necessitate either lameness or the use of a crutch or high shoe. But in order to appreciate its importance justly, let us look at it a little more closely. From birth to adult life the body grows 3.37 times its original size. But were you to take a baby and model the statue of a man after its proportions, so that head, trunk, arms and legs were each enlarged three and a third times, you would have a monstrosity. Different parts of the body grow at very different rates. Roughly speaking, the head and neck grow two and one-half times, the trunk three times, the arms three and three-quarter times, and the legs four and one-half times in length. If we measure from the trochanter to the foot we find the whole leg grows 4.49 times in the male and 4.15 in the female. Restricting next our measures to the femur, from the trochanter to the patella it increases respectively in the two sexes 4.94 and 4.57 times. This includes both epiphyses of the femur, and shows that the growth of the

lower extremity is not uniform, but is greater in the thigh than in the leg. But if we measure from the perineum to the patella, we exclude the upper epiphysis and measure only the growth due to the lower one; and here we find the most rapid growth in the *entire body.* It increases in the male 7.30 times, and in the female 6.75 times—more than double the rate of growth of the body as a whole. This shows that the chief growth of the femur is at the lower epiphysis, and is due, doubtless, chiefly to its later ossification as compared with the upper. Who, then, would be so rash as needlessly to injure it in any operation? Unless it *must* be sacrificed, the facts I have stated cry, Hands off! [1]

But this tubercle is also a guide to the upper margin of the trochlear surface of the femur in case it cannot be felt or seen. We are very apt to think of this groove in connection only with the bone, but a moment's inspection of the knee of the model in flexion shows it to you clearly through all the soft parts, and its outlines can be followed down to their contact with the tibia. Indeed, it can be seen even through the clothing. I need not point out the value of an examination of such outlines in cases of gunshot wound, suspected fracture, or inflammation of the cartilage or bones. Especially, however, is it important to note, as on this ligamentous preparation, how movable is the patella and to what a very large extent this trochlear surface, covered by the patella in extension of the leg, is exposed to manipulation when the leg is flexed.

In connection with this movable patella in varying positions of the leg, observe one very important fact as to the

[1] In a paper in St. Thomas's Hosp. Repts., Vol. X., 1880, p. 277, Mr. Wagstaffe gives a striking commentary on these facts In the 25 cases of knee-joint diseases (not operations) reported, 76 per cent. showed an appreciable alteration in length; in 56 per cent. there was elongation, the result of hypernutrition; in 16 per cent. shortening, and in one case though the whole leg was as long as the other, the tibia was shortened and the femur lengthened each 2 cm. The greatest alteration in any case was 6.6 cm., and this after only one year of disease, the boy being 14 years old.

synovial membrane of the knee. We are apt to think of it as terminating at the margin of the trochlear surface. But this is far from true. It extends, usually, as you see in this ligamentous preparation, about 5 cm. (2 inches) above the upper margin of the patella when the leg is extended, and is gradually pulled down by the patella as flexion proceeds until, in extreme flexion, its upper limit is about at the upper border of the trochlear surface.[1] Hence, in all operations near the knee joint at its upper margin, the incisions ought to be made while the knee is in flexion.

When the leg is completely extended and the quadriceps is relaxed, the posterior ligament of the knee is tense, and the knee, as in storks, is "locked." Usually, along with this

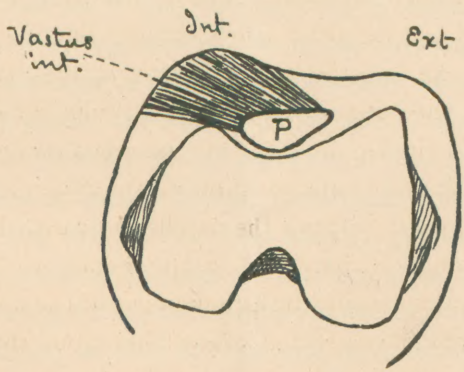

FIG. 3.—PATELLA AND CONDYLES OF LEFT FEMUR VIEWED FROM THE KNEE-JOINT.[2]

the corresponding hip is locked and all the tension here comes on the inverted Y ligament. The opposite leg is flexed and the pelvis sinks on that side so that the height of

[1] The following day I was so fortunate as to hear Prof. C. L. Ford's anatomy lecture, when he illustrated on the subject very admirably this widely-extended synovial membrane, by a blowpipe driven through the patella into the cavity of the partly-dissected but still unopened joint. Every inflation of the joint showed not only the great extent of the synovial membrane, but also several other later points—*e. g.*, dropsy of the joint, etc.

[2] This vast. int. is only diagrammatic, and is intended to call attention to its great thickness over the int. condyle and not to show its mode of insertion into the patella.

the person is diminished about one and one-half inches. It is surprising, however, to see how little variation takes place in this in persons of different heights. Thus, in a person five feet four and one-half inches in height the loss of height was one and four-eighths inches, and in a person just six feet high the loss was one and five-eighths inches. In this same locked knee, or when in sitting the weight of the extended leg comes on the heel, you will note the mobility of the patella; and in moving it sideways you will appreciate anew the far sharper hill formed by the external condyle, and therefore its greater resistance to dislocation in this direction, though the knee looks largest on the inside on account of the lower belly of the internal vastus (see Fig. 4). And it is just here that such resistance is most needed; for, be it noted, the thigh and leg are not in a straight line, but, since the thighs converge and the legs are vertical, they form an obtuse angle on the outside of the knee. When the quadriceps then acts on the leg and tends to assume a straight line —*e. g.*, from the anterior superior spine to the tubercle of the tibia—the tendency is to throw the patella outward. But besides the resistance encountered in the bones we have a more powerful safeguard in the arrangement of the muscular fibres. I have not the dissected subject here, but this cast, taken directly from a good subject at the Academy of the Fine Arts in Philadelphia, will reproduce it to you. The fibres of the external vastus terminate near the upper border of the patella and terminate obliquely; the fibres of the internal vastus extend nearly as far down as the lower border of the patella, and, moreover, they run transversely, and so guard the patella from external dislocation—an aid, too, that is exerted most powerfully at the moment when most needed, *i. e.*, when the quadriceps is tending to produce such a dislocation. But turn from the cast of the dissection to the living model. Let him call the muscles of the knee into

vigorous action, and then note here the high external vastus, there the lower and stouter internal, here the patella and there the "supra-patellar flat," as artists call it *i. e.*, the tendon chiefly of the rectus, and here the ligamentum patellæ and then, if never before, you will appreciate not only the facts to which I have asked your attention but the value of this method of studying anatomy. It adds a living interest to it that the cadaver cannot give; muscles can be relaxed

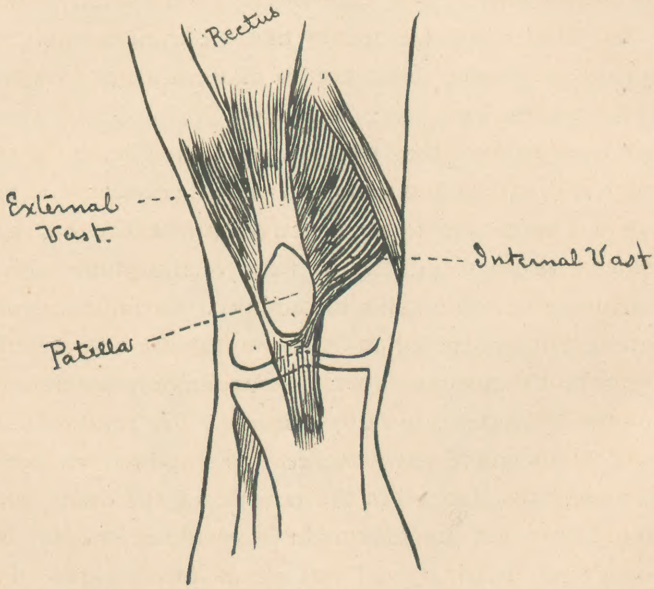

FIG. 4.—THE FIBRES OF INSERTION INTO THE PATELLA OF THE VASTI MUSCLES.

or contracted and their reliefs studied in relation to vessels, nerves or other neighboring organs of importance; the lungs can be perceived in expansion and contraction; the position of the stomach, the liver, the intestines, the bladder, etc., can be shown; the course of the arteries exhibited; movable bones shown in various positions; the relations of parts in different postures shown clearly and in their relations to medicine, surgery, obstetrics, etc., and all shown at the most important

time—*i. e.*, the very moment when they are being studied. I began this method of studying anatomy with my classes some twelve years ago, and I have been more and more constantly and increasingly impressed with its value from year to year. So true is this that I venture to affirm that *the living model should form as indispensable a part of the means of illustration in the anatomical lecture room as the cadaver.* In not a few respects, indeed, it is even more important. If its inconvenience and expense be urged, I may remind you that one model we always have—ourselves—and it is surprising how much anatomy we may learn from studying our own bodies.

But besides the fibres of the vasti which reach the tibia through the patella and its ligaments, others, whose tension can be felt on each side, go directly to the tibia, and these, together with the tensor vaginæ femoris and glutæus maximus which reach the tibia through the fascia lata, explain why it is that in cases of ankylosis or fracture of the patella or rupture of its ligament, we not uncommonly see a moderate amount of extension still retained. The tendon of the tensor vaginæ femoris is best seen by standing on one leg and crossing the free leg to the outside of the other, where it should bear just enough weight to steady the body. You see it shows in the model, but shows feebly. Had we a female model it would show far more sharply.

The ligamentum patellæ is best seen in about two-thirds extension of the lifted leg, the foot being unsupported. Tension then brings it into relief. Its condition, moreover, may be of use, even in so distant an injury as fracture of the neck of the femur. My friend Dr. Cleeman, I believe, first called attention to this fact: that the ligament may be relaxed and wrinkled in consequence of the approximation of the two points of attachment of the muscles. It will not always be the case, but it may sometimes help us, and in such obscure

cases as these often are, not even slight helps are to be despised, as you know. In dropsy of this joint, as this ligament resists the pressure of the fluid so much more firmly than the looser capsular ligament on each side of it, it forms a furrow flanked by the dropsical swelling. But this must not be confounded with the slighter normal bulge on each side of the ligament, due to the fat beneath it. This fat in flexion recedes within the articular cavity, but in extension is quite evident. Another effect of any considerable effusion into the joint is the lifting up of the patella so that it is no longer in contact with the femur. In the model you note that a blow on the patella is received at once by the femur, but in dropsy of the knee joint the patella has an elastic cushion of fluid behind it, whose resilience is perceived, and on sudden pressure the patella is felt to strike against the femur. Both of these signs are wanting in peri-articular effusion; from the difference in the physical conditions the swelling is uniform, and impact is absent. In well-nourished young children, however, it is to be remembered that the fat about the knee is so great that it causes great transverse creases, and may obscure the differential diagnosis just referred to. It acts as an important protective cushion until the ossification of the patella, which does not begin till about two and one-half years of age.

I need scarcely refer to a third variation in form of the knee—viz., that of housemaid's knee due to the distension of the bursa over the patella. Its median position, its projection directly over the patella and its limitation to this spot, together with its history, proclaim its character at once.

Placing the knee in about one-third flexion—as the model does now—you notice the transverse furrow between the tibia and the femur, and then you can examine the proximal surfaces of these bones to a considerable extent, and determine

their condition. The internal tuberosity of the tibia, the external, with the attachment of the tendon of the tensor vaginæ femoris, are both to be studied till we are familiar with their outlines. Nor must the head of the fibula be overlooked. Its form is to be studied, and also its position—not lateral, but postero-lateral.

Let us look next at the tendons behind the knee. Besides the gracilis and the sartorius, which, by the way, are only tendinous below the knee, we have three chief tendons, called the ham-strings, the semi-tendinosus, and -membranosus internally and the biceps externally. The biceps tendon is easily felt, and the other two can be differentiated with a little care. The slender cord next the popliteal space is the semi-tendinosus; and, as you see now, I can slip my finger some distance into the interspace between it and the semi-membranosus. And now let me direct your attention to one fact very prominently perceived at the knee, but which has its repetitions at not a few points over the body. Try an experiment on yourselves to-night. Stand, as the model is, with your back against the wall, keep the pelvis fixed, and then flex the knee as far as you can on the trunk. You see you can almost make the knee touch the belly; but observe that the leg is flexed on the thigh as is the thigh on the pelvis. Now vary the conditions; flex the thigh as before, but keep the leg extended. You see that the heel can only be lifted a short distance from the ground; and on trying the experiment personally you will find that any effort to carry the rigid leg higher will produce a sharp pain behind the knee. Now flex the knee, and, as before, you can carry the bent knee as high as you please. Why? Because the raising of the rigidly extended leg stretches the ham-string muscles, and when they have once reached the limit of their natural extension, what Prof. Cleland calls their "ligamentous action" comes into play. The distance from the tuber ischii to their tibial inser-

tion is increased by flexion up to a right angle some 6 or 8 cm. or even more. The experiment can be reversed, and is then a reminiscence with nearly all of us. Keeping the knee rigid, try to bend over and touch the ground with the fingers. Only a few, and those chiefly trained to it by practice, can do so. Flexion of the pelvis on the rigid leg is limited by the ham-strings, as was flexion of the rigid leg on the pelvis. Try a similar experiment with the wrist (and you can do so at the instant). The fingers being extended, flex your wrist, and you see that in general you can flex it to the right angle. Next extend the wrist, and then flex it again, but not now with the fingers extended but made into a "fist." Instead of reaching 90°, you see that flexion in my wrist scarcely passes beyond 30° or 35°, though in others it may (though rarely) pass even to 60° or 70°. In other words, the extensor muscles, by making a fist, were stretched nearly to their limit, and, on flexing the wrist 30°, their extreme limit was reached and flexion was arrested. Now, what lesson shall we learn from this? That in all cases of passive motion (as to prevent anchylosis or after fracture of the thigh or at the wrist, etc.) we must be careful not to o'erstep the bounds of nature. We must not flex the wrist with fingers already flexed but extended, nor flex the thigh with the leg extended but flexed. And it is because I have so often seen needless, nay more, positively harmful torture inflicted by such injudicious passive motion, that I insist so strenuously on the point. To ascertain the limit in the individual patient, "take the bearings of the other leg," as I once knew a shrewd captain to state his method of treating a fracture at sea.

Dr. Allis, who has studied fractures and dislocations, as you know, with such admirable discrimination, proposed some time since a new physical sign to diagnosticate a sciatic dislocation of the femur. He places the patient on the back, with the legs elevated at right angles to the trunk, when the

dislocated leg will be as much shorter as the sciatic notch is behind the acetabulum. On the skeleton and in children this can be done exactly, but rarely will it be found practicable with adults except the knee be *first flexed*. This will impair the value of the method, since the measurement must then be made from the ant. sup. spine of the ilium to the tubercle for the tendon of the adductor magnus or to the patella, both less accurately defined points than the malleolus.

You will remark that I said "on the skeleton and in *children*," for we have here an interesting example of another fact which we doctors are apt to overlook. The best acrobats of the circus, as a rule, are trained from childhood, when the limbs are so much more supple than in later life. Look at one of your children sitting on the floor, and see how without any effort—without even leaning back—he can raise his heels from the floor, making the hip the apex of an acute angle between the leg and the trunk! The facility, too, with which young children can put their toes into their mouths every one knows. Now, this dexterity and flexibility do not only come from shorter legs, but from an anatomical difference in the very structure of the muscles in childhood and adult life. Starting from adult life as we go backward towards adolescence, youth and infancy, we find progressively more muscular substance and less tendon in the muscles; that is, more of the contractile and elastic tissue and less of the inelastic. With every year from birth to old age the fibrous tendon invades the belly of the muscles and reduces our suppleness of joint and sinews. The caution I gave you, therefore, as to passive motion is to be modified somewhat by the age of the patient.

Between the hamstrings lies the popliteal space, and with our model standing on one foot and resting the other on the seat of a chair, you appreciate with ease the difference of the mechanical conditions; how readily the space is invaded

by pressure in the flexed leg, so that the artery can be compressed, while in the extended leg the surface is rigid, elastic, and instead of being a hollow is a projection. This is caused chiefly by the posterior projection of the large femoral condyles in extension, together with the tightening of the hamstring tendons and the fascia surrounding them. Directly through the middle of the space runs the internal popliteal nerve but a little distance below the skin, then comes the vein, then the artery next the bone, and therefore susceptible of such pressure by flexing the knee, that this is, as you remember, a recognized method of treating popliteal aneurism. It must not be forgotten that, while in the lower part of the ham these three overlie one the other, in the upper part the vein and artery lie successively a little internal to the nerve. The external popliteal nerve has even a more important relation than the internal. It lies immediately alongside of the tendon of the biceps and the head of the fibula to their inner border. It can be felt and snapped like a violin string in thin persons. In tenotomy of the biceps it is most carefully to be avoided, for, if severed, paralysis of the anterior muscles of the leg, and what may be called "foot drop," results.

I must pass over, I find, several other interesting points about the knee, and come to the ankle-joint; and first note the two malleoli. How different their shape and position: the internal is square, the external conical; the external is not opposite to the internal, as in the lower animals, but is below and behind it. And this may aid us in fractures both in diagnosticating the line of fracture, if obscure, and in the accurate reposition of the parts; for when the knee is straight forward the foot naturally is slightly everted; or, if the foot be straight forward the knee is slightly inverted. In rickets and chronic periostitis, also, the enlargement especially of the internal malleolus may be of much diagnostic value.

Again, the familiar mortising of the astragalus into the intermalleolar space, as I pointed out some ten years ago, may be of great value in diagnosticating Pott's fracture of the fibula, and I have often found it present and decisive when the other usual signs were either obscure or absent. Looking at this ligamentous preparation, we see that this mortise is exact. It allows no lateral "play" to the astragalus.

But when the fibula is broken three or four inches above the ankle, if you grasp the leg with the left hand at this point, the upper end of the lower fragment approaches the tibia; the lower end, the malleolus, must be tilted outwards, thus widening the intermalleolar space considerably. Seize, now, the foot with the right hand, the palm being under the sole and the thumb and fingers grasping the astragalus from below, push it sidewise towards the fibula as far as you can, as you see me attempt in this unbroken leg; then suddenly shove it sidewise towards the tibia, against which it will come with an easily-perceived impact if fracture exist. If none exist, the astragalus cannot be separated from the tibia, and, therefore, cannot strike it. One caution is needed. You must not mistake lateral flexibility of the foot at the medio-tarsal joints for the tibio-

FIG 5.— POTT'S FRACTURE OF FIBULA, SHOWING WIDENED INTER-MALLEOLAR SPACE.

tarsal lateral movement—a mistake very easily made unless we are on our guard.

In extension, as you can readily see, both on the model and in this ligamentous preparation, a surprisingly large portion of the articular surface of the astragalus is amenable to our touch (Fig. 6), and the two ridges between the lateral

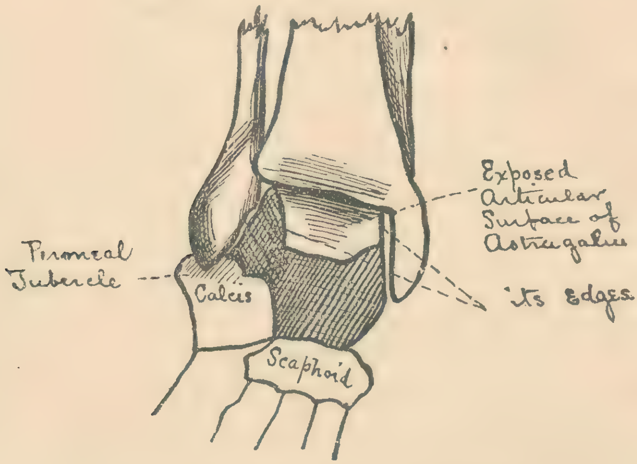

FIG. 6.—THE ANKLE JOINT IN EXTENSION.

and upper surfaces are perceptible even to the sight, as well as to touch. This it is very important to recognize in cases of accident. In one obscure case of comminuted fracture of the astralagus, with dislocation of the fragments, I was enabled to determine the nature of the accident chiefly by this sign, the dislocated part being thrust between the tibia and the tendo Achillis, but recognizable by its shape. It is not to be forgotten, also, that the articular surfaces of the astralagus do not form a rectangle, thus, but a truncated wedge, like this.

Not uncommonly as a result of sprains, the inner wall of one of the malleoli through tension on the ligament may be broken. You see how thick the malleoli are, and how readily a sliver of the articular surface may be broken off.

Crepitus may rarely be obtained, but by no possible means can the broken fragment be felt on the exterior; and yet, the joint may be most seriously injured, and its usefulness even destroyed. Mr. Callender has named such accidents, very happily, "sprain fractures."

Placing the model now on one foot, you notice how, as his equilibrium is disturbed, several tendons in front of the ankle repeatedly spring into relief and subside again, in the effort to maintain the erect posture. This—the most prominent one just in front of the internal malleolus, and running obliquely to the inside of the foot—is the tibialis anticus; next it is the extensor proprius pollicis, and next to that the several tendons of the extensor longus digitorum. All the tendons are held down by the anterior annular ligament—the anterior tibial very loosely, the others much more firmly. In Dr. Fisher's admirable series of papers on the older anatomists, you will remember an excellent illustration of this use of the annular ligaments taken from Vesalius. (See ANNALS for January, 1880, page 37.)

Behind the external malleolus you note also during the same unstable equilibrium of the body on one foot how the long and short peroneal tendons alternately become prominently visible and relax, displaying admirably their function. Between the inner malleolus and the heel there are three others, perhaps even more important on account of their relation to the posterior tibial artery and nerve. Like all the other tendons, they too, are kept in place by an annular ligament. In a line from the malleolus to the heel the artery is the middle one of five structures—viz.: 1. The tendon of the tibialis posticus; 2. The flexor longus digitorum; 3. Artery; 4. Nerve; 5. Tendon of flexor longus pollicis. Of all these, the last is most easily felt on passive motion of the great toe, and this, with the midway measurement from malleolus to heel, will give us exactly the

position of the artery, and next it the nerve. Wyeth has shown that its bifurcation is indicated by a line from the tip of the malleolus to the middle of the heel—an important point in Syme's operation. The posterior tibial tendon can also be felt at three points—viz.: above the malleolus, at the internal border of the tibia; below and in front of the malleolus; and between the malleolus and the scaphoid. Active but resisted adduction of the foot with extension, you will readily find, on trial, reveals it best. The same action with flexion shows the anterior tibial tendon. Both of these being powerful adductors, are naturally productive of talipes varus if their action be unbalanced by spasm of their muscular bellies or paralysis of the peronei, their natural antagonists.

With the bony landmarks of the foot and ankle you are to a large extent so familiar, that I venture to enter into detail only in a few points, some of which, I think, are generally overlooked or forgotten. Starting from before backward, first on the *inside* (Fig. 7), we find very easily—

1. The tuberosity on the base of the first metatarsal, at which the operation of Lisfranc is done. This is in general readily found.

2. The internal cuneiform. This is not readily found, as a rule, for the projection is slight; but it can be easily determined in two ways: (*a*), it is nearly midway between the base of the first metatarsal and the scaphoid; and (*b*) a line drawn transversely across the foot from the base of the fifth metatarsal, will strike usually the joint between the internal cuneiform and the scaphoid. One inch (scant) in front of this, and therefore *obliquely* across the foot lies the joint between the internal cuneiform and the first metatarsal. You will find these points of value in determining the point for Lisfranc's operation, and in cases of caries, necrosis and injuries of the foot.

3. The scaphoid tubercle is very easily determined. Behind it the operation of Chopart is done.

4. On a line and nearly half-way from the scaphoid to the internal malleolus the internal border of the head of the astragalus can generally be easily perceived. This forming the keystone of the antero-posterior arch of the foot and resting on the elastic calcaneo-scaphoid ligament is a point of great value in cases of injury.

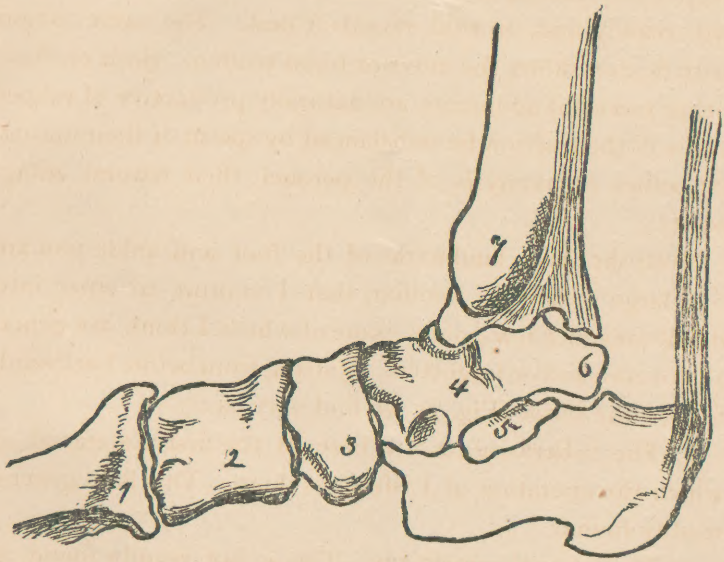

FIG. 7.—INNER BORDER OF FOOT.

5. The sustentaculum tali is a point usually entirely overlooked. Yet there are few feet, and those only very fat ones, in which it cannot be felt just behind and nearly an inch below the internal malleolus and behind the tendon of the tibialis posticus. The tendon of the flexor longus pollicis lies close under its shelter.

6. Behind and about half-way between the level of the sustentaculum tali and the internal malleolus, and nearly half-way towards the tendo Achillis is another projecting tubercle. This is not like the sustentaculum on the calcis,

but is the posterior projection of the astragalus. Behind it also lies the tendon of the flexor pollicis.

7. The internal malleolus.

Next on the *outside* we feel—

1. The base of the fifth metatarsal. Just behind it the Lisfranc operation is done, and midway between it and the external malleolus is the calcaneo-cuboid articulation for Chopart's operation. In operating on the right foot we must be very careful not to forget that the line of the incision is an italic and not a simple convex line, otherwise in going from within outward we shall get into the deep hollow between the astragalus and the calcis, and behind the calcaneo-cuboid articulation.

2. Another guide in Chopart's operation to this same articulation is a tubercle on the anterior edge of the calcis in front of the external malleolus, and about on a level with it. It lies also just behind the extensor brevis. The articulation is just in front of the tubercle.

3. The peroneal tubercle. This lies directly below the external malleolus nearly an inch away, and the peroneus longus tendon passes behind and under it on its way to the sole of the foot. When well developed, and it sometimes projects as much as half an inch, this is easily found; but like the last tubercle this varies much, and is not seldom nearly absent.

4. The external malleolus.

I should like to continue with you the study of the foot, its arches, both antero,- postero- and lateral, the anatomy of the sole of the foot in its outline and axis, its arteries, nerves and muscles, and many other points of interest and usefulness, but time forbids.